returns at 4 p. m., remaining until 10 p. m. The other goes off duty at 11:30 a. m. and returns at 6 p. m., remaining until 10 p. m. One nurse comes on duty at 12:30 noon, and remains until 9 p. m. The two night nurses are on duty from 10 p. m. until 7:30 a. m.

This schedule gives the day nurses and those working on split hours, eight hours on duty and the two night nurses nine hours on duty; this has proven satisfactory to the hospital so far. The hours of duty for the group nurses are changed weekly, so that no nurse has the same hours of duty for more than one week at a time, with the exception of the night nurses who are on duty for one month at a time.

This system, almost without exception, meets the approval of the physicians who have had patients in this division. Each physician who has been approached for an expression of his views has been heartily in favor of the plan, as giving the *more than necessary* attention to this class of patients, who cannot afford the services of a special nurse.

There has been no dissatisfaction on the part of the patients, so far, and many have expressed themselves as thoroughly pleased. Those who have received treatment in this division and who, for any reason, have found it necessary to return to the hospital, have made special request to be put in this division, which emphasizes the superiority of this kind of service.

From the nurses' standpoint, all who are engaged in this work enjoy it and only two or three have dropped out since its inception. The salary and hours are attractive and the class of patients are pleasant to meet and appreciative of the care given them.

Owing to its short duration, the system of group nursing is not without its perplexities, but these are gradually being eliminated through experience and practice.

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## THE SCHICK TEST AND ITS PRACTICAL APPLICATION IN THE CONTROL OF DIPHTHERIA

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PROBABLY the greatest advance in the study of diphtheria since the discovery of antitoxin is the Schick Test now coming into more and more prominence in the study of the means of controlling this infection.

While in antitoxin modern medicine has a weapon which, if properly used, will effectually control the mortality of the disease,

equally effectual means of controlling its spread and dissemination have not until now been available, and it is this need which, apparently, the Schick test will supply.

Following the introduction in 1894 of antitoxin as a method of treatment, the mortality of diphtheria gradually declined from 75 per cent to 10 per cent, at which figure it has remained practically stationary. In spite of the fact, therefore, that in antitoxin we have a method of treatment which, if intelligently used *early* in the disease, would cure every case, the disease still occurs sporadically,—and occasionally epidemically,—and the mortality remains relatively high. This may be accounted for by several factors: delay in the recognition of the disease and in the application of treatment accounts for the mortality; and the fact that there are "carriers" of predominant importance in the spread of the infection supplies a focus for its dissemination, while the existence of susceptible individuals supplies a reason for its continual occurrence.

While it is true that prophylaxis by means of the injection of antitoxin is effective and of great value, unfortunately, the passive immunity thus conferred lasts but a short time,—generally about two weeks. To maintain this immunity over any length of time requires bi-monthly injections of antitoxin, a procedure manifestly impracticable; moreover, the incidence of "carriers" remains unaffected. Considering the fact that approximately one per cent of the population of any large city, especally in the winter months, harbor in their throats virulent diphtheria organisms, the incidence of the disease is readily explained.

As the detection and isolation of such large numbers of "carriers" is manifestly impossible, the problem of the control of diphtheria, in its simplest terms resolves itself into, first, the detection of those susceptible to the infection and, second, their permanent immunization. These premises fulfilled, the eradication of the disease becomes possible.

The discovery in 1913 by Schick of a means of singling out those susceptible to diphtheretic infection by the test now known as the Schick reaction, and the immunization of such individuals by a method designed to produce an *active* and lasting—instead of a passive and temporary—immunity, constitute an important advance of equal value with the discovery of antitoxin.

*Mechanism of the Schick Reaction:* Prolonged investigations have shown: (1) approximately 60 per cent of children between the ages of 1 and 5 and approximately 90 per cent of adults have in their blood as a normal constituent an amount of antitoxin sufficient to render them relatively immune to diphtheria. The source of this

antitoxin is not always clear. While recent investigations have shown that antibodies of various kinds may be transmitted from the mother to the foetus in utero, it seems likely that, in view of the widespread distribution of the diphtheria bacillus, minor sub-infections are possibly a not infrequent source. (2) Only those in whose blood antitoxin is absent are susceptible to the usual methods of infection.

The Schick reaction is designed to detect those individuals in whose blood antitoxin is absent and who are, therefore, unprotected; the second step is their active immunization by a method to be later detailed.

*Technic of the Schick Reaction:* The purpose of the test is to determine whether or not the blood of the individual tested contains perceptible amounts of antitoxin and the method adopted for this purpose is the injection of a small amount of diphtheria *toxin.* If antitoxin is present the injected toxin will be neutralized and no reaction will occur; if antitoxin is absent, a reaction will be noted purely inflammatory in character and due to the presence of non-neutralized toxin acting as an irritant. The reaction is, therefore, inflammatory and not anaphylactic as in the tuberculin and leutin tests.

The toxin for injection is secured by growing pure cultures of B. diphtheriae in boullion from which the organisms are later filtered off, the clear boullion filtrate containing the diphtheria toxin in solution.

After having been tested for sterility, the toxin is injected in varying amounts into a series of 250 gram guinea pigs in order to determine the smallest amount capable of causing death in four days. This amount is known as the Minimum Lethal Dose or M. L. D., and the amount used for injection in the Schick reaction is one-fiftieth of the M. L. D.

To make the test, the skin of the forearm or of the deltoid region is cleansed with alcohol and the toxin, so diluted that one-fiftieth of the M. L. D. is contained in 0.2 cc of normal saline, is injected *intracutaneously.* It is essential that the injection be made *into* and not *under* the skin in order that the toxin may not be too rapidly absorbed, but may remain in the dense tissue long enough to manifest its irritant action. At the same time a control injection is made in the same area in the other arm, using heated (inert) toxin to serve as a control both of the reaction due to trauma and that due to the injection of foreign protein material.

When the injections are correctly made a *white, raised wheal* appears at the site and unless this is seen the injections have been improperly made.

A *positive* reaction indicates that the toxin acted as an irritant

and was not neutralized and, therefore, antitoxin was absent and the individual is susceptible to infection.

A *negative* reaction indicates the presence of antitoxin in amount sufficient to neutralize one-fiftieth the M. L. D. of diphtheria toxin and render it inert and, therefore, such an individual is, presumably, not susceptible to infection by ordinary means.

*The Positive Reaction* is denoted by a circumscribed area of redness and slight skin infiltration (induration) measuring from one to two cubic centimeters in diameter, persisting from 7 to 14 days, and which, on fading, presents a slight scaling of the skin and a fairly persistent brownish discoloration.

*The Negative Reaction,* obviously, shows nothing more than the trauma due to the injection and is comparable to that seen in the control area.

*The Pseudo-Reaction:* In a certain percentage of individuals tested, a reaction occurs which is due entirely to the anaphylactic effect of the foreign proteins injected which are derived both from the bacterial cells and from those contained in the boullion. This reaction is, usually, distinguishable from the true reaction in that it comes on more promptly, covers a larger area, is more urticarial in type, and disappears within three days leaving little or no pigmentation. Occasionally, however, the reaction due to proteins is combined with a true reaction and in case of doubt it is better to either repeat the test or consider the reaction as positive.

*Practical Value of the Schick Reaction:* By means of this test it has been shown that the incidence of susceptibility to diphtheria is greatest between the ages of 1 and 4; less in infancy and in older children and least in adults and in infants under six months.

Moreover, a negative test, as a rule, remains negative, thus indicating that natural immunity once acquired is probably permanent. Practical experience has shown that such individuals, if not absolutely immune, are not likely to develop a severe general toxemia. The reaction is a means, therefore, of distinguishing the susceptible from the non-susceptible elements of the population and determining those who must be protected from the disease. It renders it possible, not only to avoid unnecessary antitoxin injections in the case of large groups in schools and institutions, but also, to bring up, by means of active immunization, a non-susceptible population.

*Immunization:* The prophylactic administration of diphtheria antitoxin produces a purely *passive* immunization of temporary character lasting not longer than fourteen days. The method introduced by von Behring in 1913, using a toxin-antitoxin mixture, produces an *active* immunity of high degree which is practically permanent.

To produce active immunization by the injection of diphtheria toxin alone necessitates, because of the high toxicity of the poison, a very minute initial dose and a long series of injections. Moreover, there is always an element of danger in the procedure. Experimentation has shown, however, that by adding to a definite amount of toxin varying amounts of antitoxin, a mixture can be obtained in which the toxin is neutralized to the extent of not being poisonous and yet is able to stimulate the production of antibodies and so produce an active immunization. Obviously such a toxin-antitoxin mixture is less stimulating to the production of antibodies than an equal amount of pure toxin, but this apparent disadvantage is more than counterbalanced by the harmlessness of the neutralized toxin and the fact that several hundred times the amount can be safely given.

The usual dose is 400 times the M. L. D. to which has been added sufficient antitoxin to neutralize it, the whole being contained in about one cubic centimeter. The mixture is carefully standardized before use and tested for sterility and harmlessness.

The injection is given subcutaneously and may be reinforced by a second and third injection at weekly intervals.

*Reactions:* The toxin-antitoxin mixture contains a considerable amount of foreign protein and, therefore, might be expected to give rise to a certain amount of reaction from this cause alone. Reactions are either local or general or both and may be manifested by considerable local swelling with or without accompanying constitutional symptoms. In any event, within 24 to 72 hours, all signs have disappeared and serious results have not been reported.

The question of age is very important as affecting the occurrence of reactions. In infants no reaction of any kind is seen, while in about 30 per cent of children from 1 to 10, and in adults, considerable local or general reaction may be expected.

While of comparatively recent introduction, the Schick reaction followed by toxin-antitoxin immunization of susceptible individuals is rapidly growing in favor and has now been utilized in many thousands of cases without any deleterious effects. By means of these combined methods all those susceptible can be recognized and rendered immune and as the method comes into general use and a non-susceptible population is produced, the absolute prevention of diphtheria becomes an imminent probability.